



# FIRST LOOK AT THE RE-COMMISSIONING PLANS AFTER LS1: HWC- DRY RUNS - SYSTEMS COMM. ...



LHC ring

ring

**MIRKO POJER – BEAMS DEPARTMENT/OP GROUP**

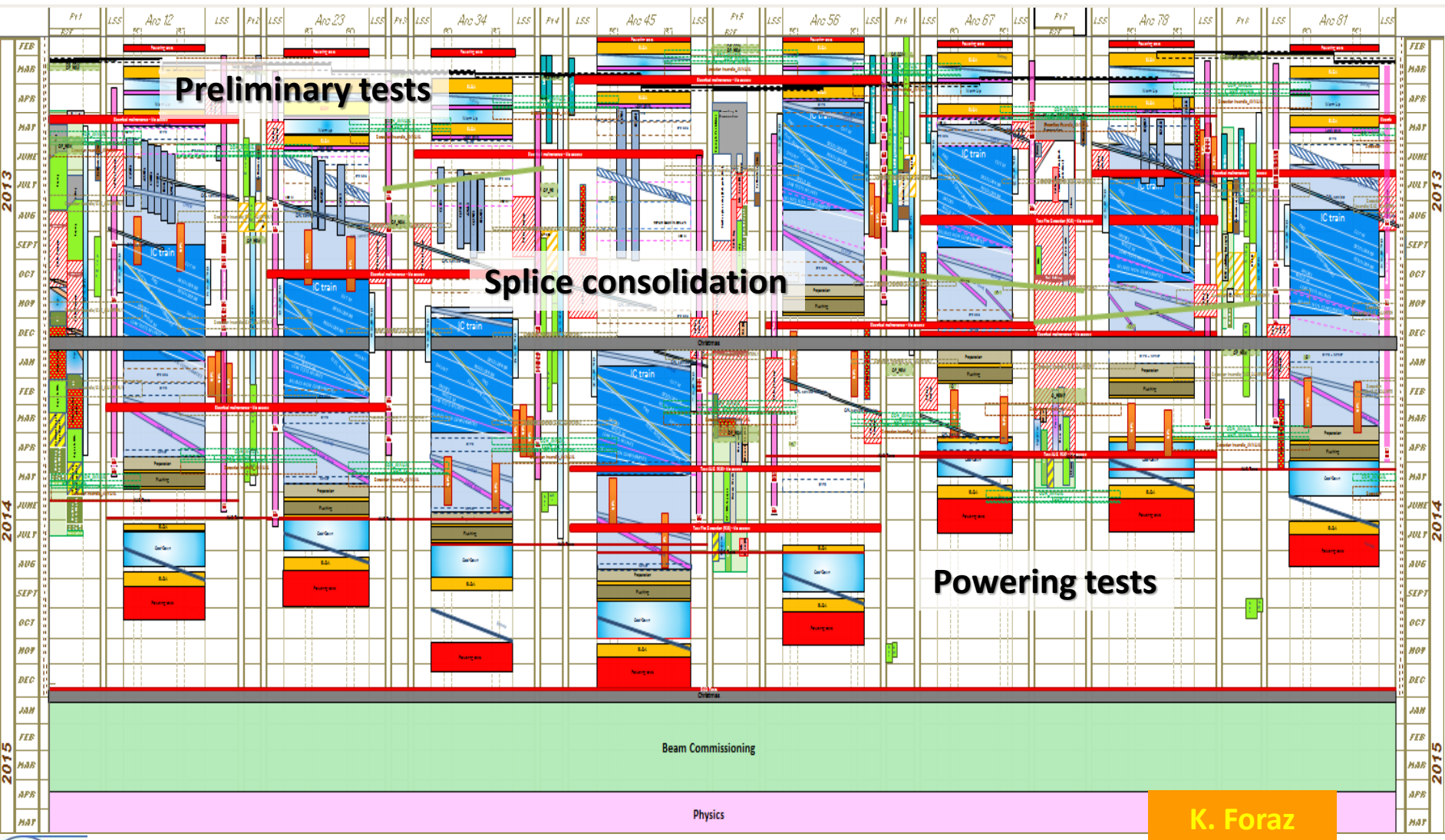
Acknowledgements: V. Baggiolini , V. Baglin, E. Carlier, S. Claudet , K. Fuchsberger, C. Garion , R. Giachino, R. Jones, P. Maesen, C. Martin, T. Mastoridis, B. Puccio, S. Redaelli, I. Romera, R. Schmidt, M. Solfaroli, H. Thiesen, J. Uythoven, D. Valuch, A. Verweij.



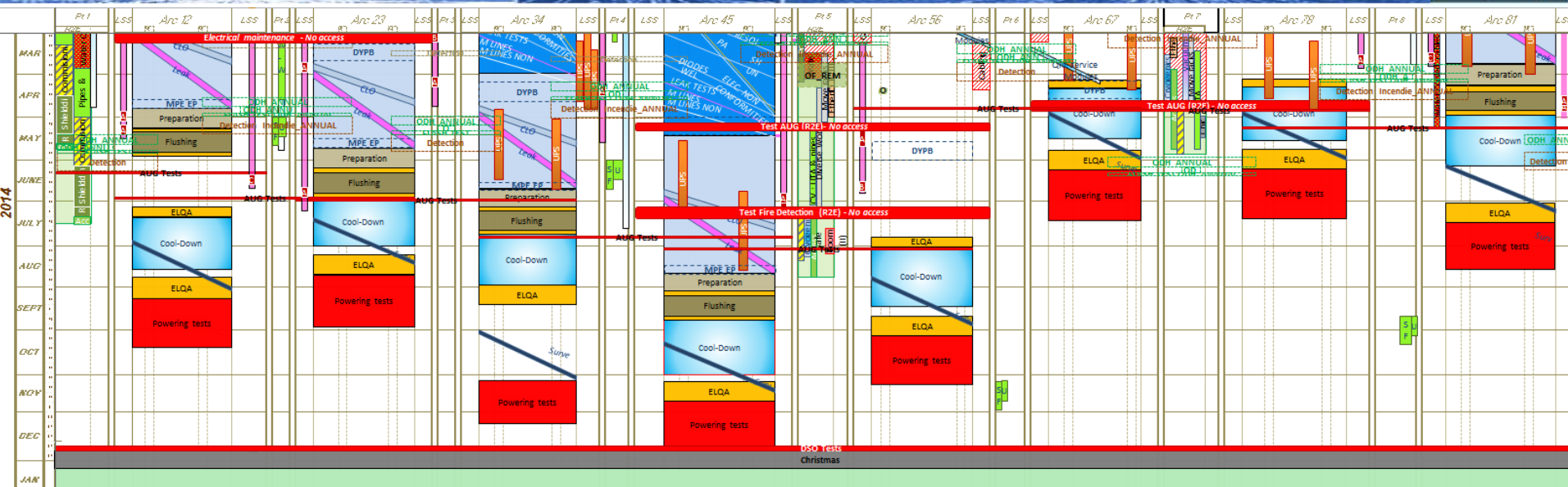
- Review of (some) relevant systems
- Major modifications
  - Replaced/repaired hardware
  - Software implementations
- “Delivery” date
- Some hints on the re-commissioning period
- Interdependency with other equipment
- Importance of dry runs
  
- Will it be 2008- or 2010-like re-commissioning?



- ❑ A quick look at the general planning
- ❑ Superconducting Circuits Commissioning
  - Thermal amplifier?
  - Powering tests
- ❑ System re-commissioning
- ❑ Machine check-out
- ❑ Concluding remarks



# SOME IMPLICATIONS OF THE TIGHT PLANNING



- ❑ R2E finishing late
  - P5 at the end of August (powering system, access,...)
  - P7 mid-July (powering, collimators,...)
- ❑ S56 (1<sup>st</sup> sector under repair) will be tested only in Autumn (no space for error)
- ❑ S45 and 56 will be the last sectors to be powered
  - LBDS tracking
- ❑ Many of us will be busy till August...and later...
- ❑ Powering tests and Dry Runs/machine check-out will have to be done mostly in parallel



- A quick look at the general planning
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# COPPER STABILIZER CONTINUITY MEASUREMENT (THERMAL AMPLIFIER)

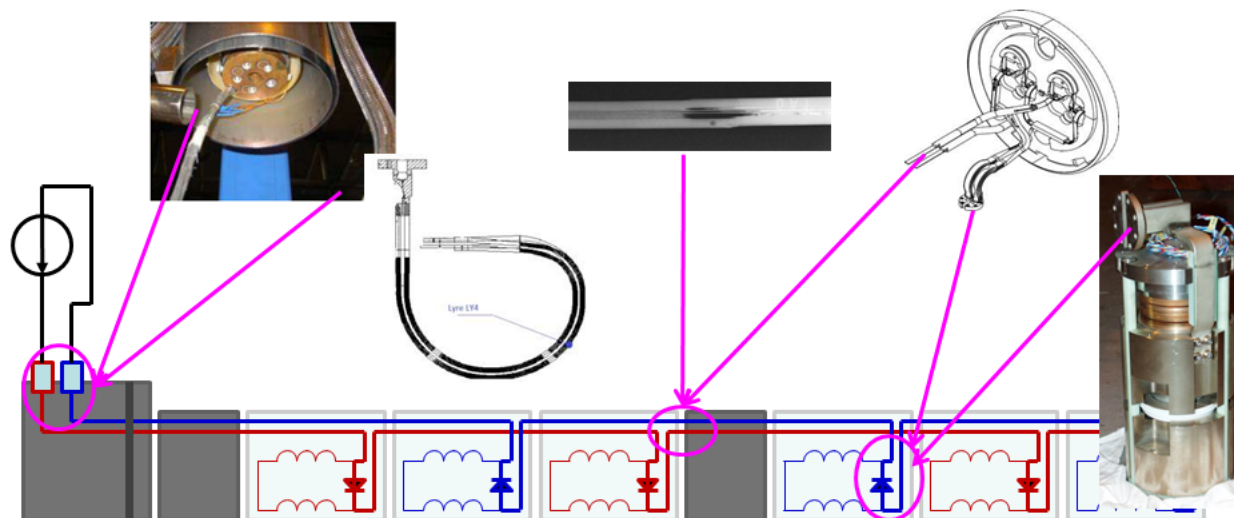


- Technique proposed by H. Pfeffer and later developed by H. Thiesen et al. to investigate thermal runaway of faulty splices of an entire line

**CSCM main goal:** qualification of the **bus & bypass** of the main circuits (RB, RQD/F) up to nominal current (7 TeV equivalent) at 20 K.

The **bus & bypass** comprises: Current leads + Pigtails + Busbars + Diode leads + Diodes + all soldered/welded/brazed/bolted connections in-between.

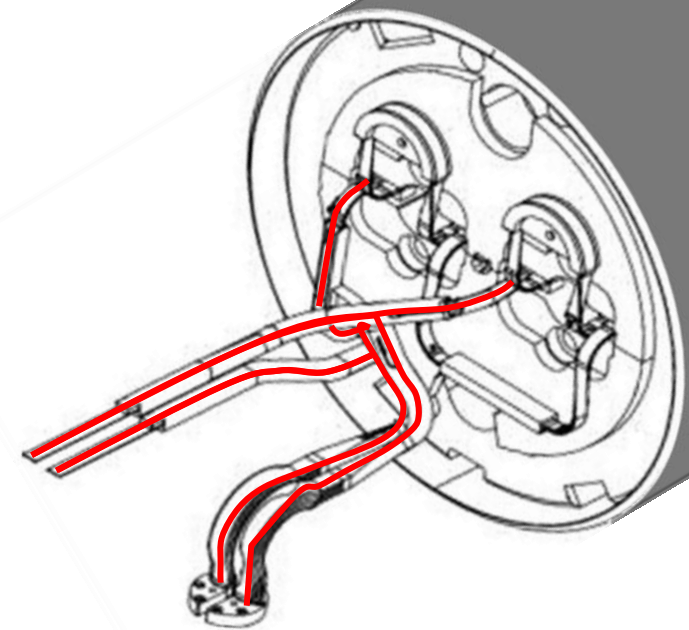
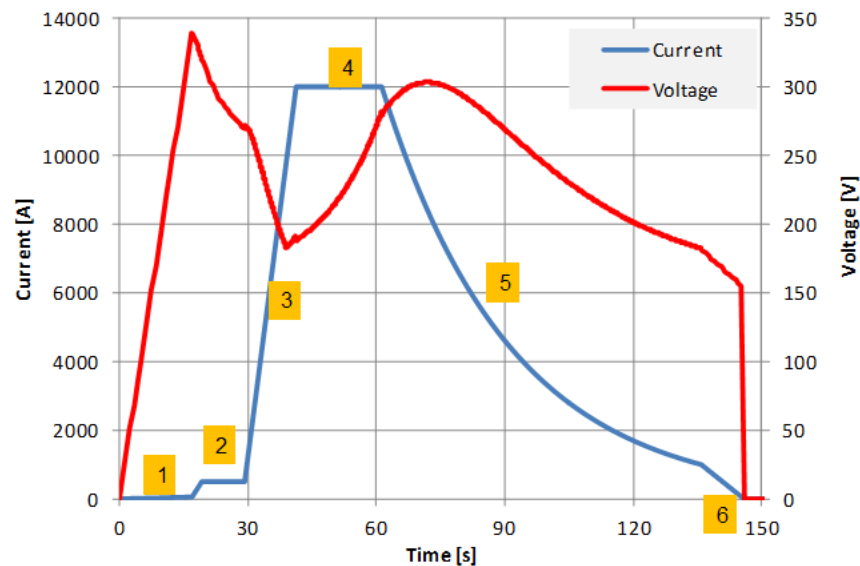
Goal of the test



Arjan Verweij, TE-MPE, CSCM review 14 Nov 2012

## □ Procedure

- 0) Magnets at 20 K
- 1) Ramp to 500A with 20V/s to open all diodes
- 2) Plateau to check if all diodes are open
- 3) Increase the current linearly from 500 A to 12 kA with  $\sim 1000$  A/s
- 4) Plateau of 2-100 s
- 5) Ramp the current exponentially down to 1000 A
- 6) Ramp the current linearly down to 0 A



To be done in sector 34 as a type test before LS1.

**To be performed on the rest of the machine in case of method qualification, after LS1.**

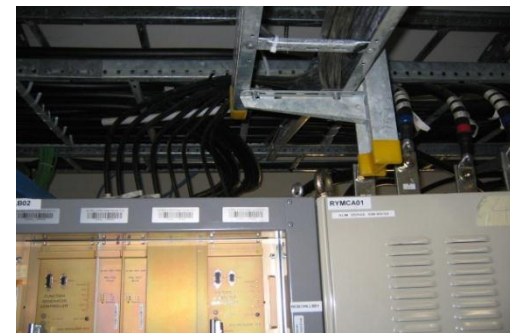
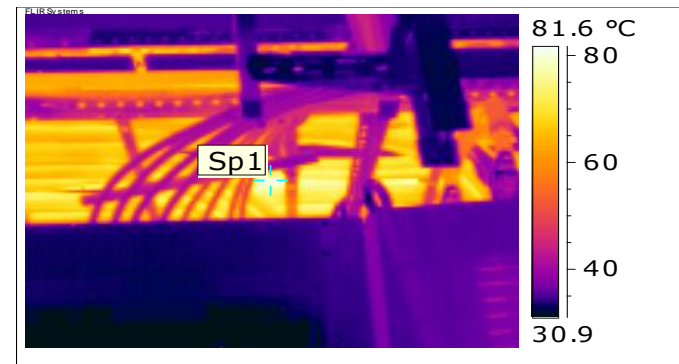




- Many system upgrade and maintenance activities will be performed during the LS1
  - QPS upgrades:
    - additional systems for the diagnostics of the quench heater circuits (measure of the resistance of the heater circuit with high precision -  $\Delta R = 100 \mu\Omega$ - in order to see precursors of eventual faults)
    - Specific transducers for precision measurement of the power pulse during heater discharge of each of the 6076 heater circuits in the LHC
    - All other QPS instrumentation cables need to be checked after LS1 for electrical insulation strength and correct wiring
    - Detectors change and firmware upgrade
  - Power converter modifications (active filters, auxiliary power supplies,...)
  - Following R2E relocations, many electronic equipment will be removed from areas close to the tunnel and put far away
  - Cable re-routing (mainly at point 5, due to R2E) and change of cable sheaths

Just some examples...

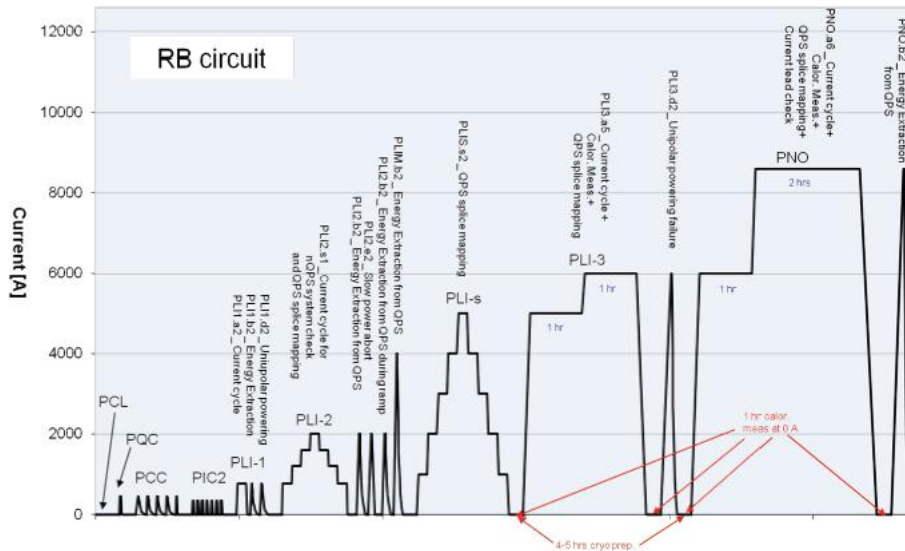
- ❑ Everything will “be messed up”...
  - Each and every ARC interconnection will be open
  - Some magnets will be replaced
  - A lot of hardware will be moved, replaced, modified
  - A lot of software will be upgraded or changed
- ❑ A **massive campaign of IST** will be performed by equipment owners; in particular, for the superconducting circuits, we’ll have to check for
  - protection functionalities
  - effective QPS-PIC-PC interface
  - systems reliability
- ❑ The cable activity will require
  - short-circuit tests
  - heat runs
- ❑ The most important part will be (as usual) the **interface between the different systems**
  - Delivery at different moment
  - Commissioning not synchronized



**Valid for most MP systems**



- New powering procedures will be needed (not only for the training of the 13 kA circuits), to keep into account the hardware and software modifications
- And later, there will be a **brand new commissioning** of the superconducting circuits and the associated systems
- Sector 67 is the pilot commissioning: expect to be long, fast learning curve later
- More than 6 months of powering tests where the **manpower could become an issue** (OP will be involved in splice consolidation).



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LHC Project Document No.  
**LHC-MPP-HCP-0001 ver 4.0**  
CERN Div./Group or Supplier/Contractor Document No.  
**TE/BE**  
EDMS Document No.  
**874713**

Date: 2012-02-12

## MP3 Procedure

### POWERING PROCEDURE AND ACCEPTANCE CRITERIA FOR THE 13 KA DIPOLE CIRCUITS

#### Abstract

This document describes the test procedure and the acceptance parameter specification for the 13 kA dipole circuits. A list of the parameters to be acquired during the tests is given, as well as the required approvals to validate each test.

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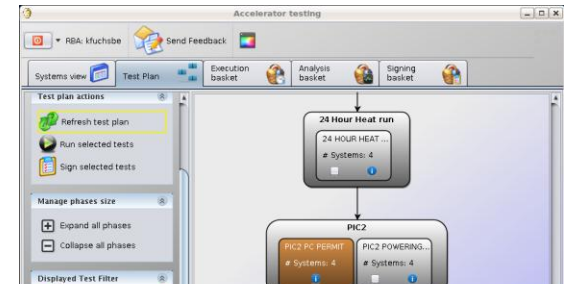
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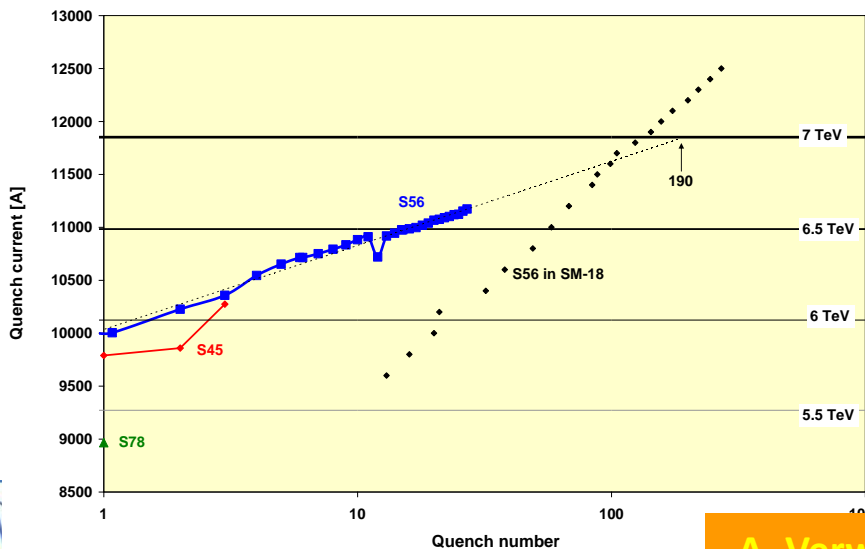
- Detailed discussion will be launched during LS1, but at a first glance
  - Nothing should change for the commissioning of the low/mid current circuits
  - Which current for which circuit? We should go for **7 TeV with all but Mains**
    - Some 600 A circuits should be limited according to known weaknesses and operation needs
    - Other parameters could be relaxed, to improve flexibility and increase performance
  - No unknown issue expected for any circuit (see tests to be performed in early 2013)
  - QPS will profit from an **increased automation**, to speed up and make commissioning safer
  - The players will be the same as usual:
    - eMP3 (A. Verweij?)
    - Automation (K. Fuchsberger)
    - Coordination + test execution (OP)
- Some **three-four weeks per sector** are reserved
- Few additional words on automation
  - It guarantees a safe commissioning
  - It speeds up the whole commissioning process
  - Increases traceable and easy way to control actual settings on devices



System name	Active locks	The tests for the system
RCBYH4.L1B1	HW	ELOA.CR... ELOA CC.EPC PC.UNLO...
RCBYV4.L1B2	HW	ELOA.CR... ELOA CC.EPC PC.UNLO...
RCBCH5.L1B2	HW	ELOA.CR... ELOA CC.EPC PC.UNLO...
RCBCV5.L1B1	HW	ELOA.CR... ELOA CC.EPC PC.UNLO...
RCBCH6.L1B1	HW	ELOA.CR... ELOA CC.EPC PC.UNLO...
RCBCV6.L1B2	HW	ELOA.CR... ELOA CC.EPC PC.UNLO...



- After LS1, we should be able to go to 7 TeV
  - Nevertheless, we know (from the commissioning of sector 56 in 2008) that the **training of the dipole magnets could be long...**
  - Also, we want to avoid a high number of quenches right at the beginning
- The **initial energy** will be presumably limited to **6.5 TeV**
  - the **commissioning energy shall be slightly higher (6.55 TeV/11100 A)**, to allow a comfortable operation)
- Length of the training campaign:
  - Suppose 2-3 quenches per day, per sector (cryo recovery)
  - --> about **1 week to train the main circuits in each sector**



Sector	Number of magnets			Number of quenches	
	ALS	ANS	NOE	@ 6 TeV (±2)	@ 6.5 TeV (±30%)
1-2	49	96	9	0	4
2-3	56	60	38	1	8
3-4	56	65	33	1	8
4-5	46	46	62	2	12
5-6	28	42	84	1	15
6-7	57	36	61	2	12
7-8	54	40	60	2	12
8-1	64	24	66	2	13
<b>Total</b>	<b>154</b>	<b>154</b>	<b>154</b>	<b>11</b>	<b>84</b>

A. Verweij

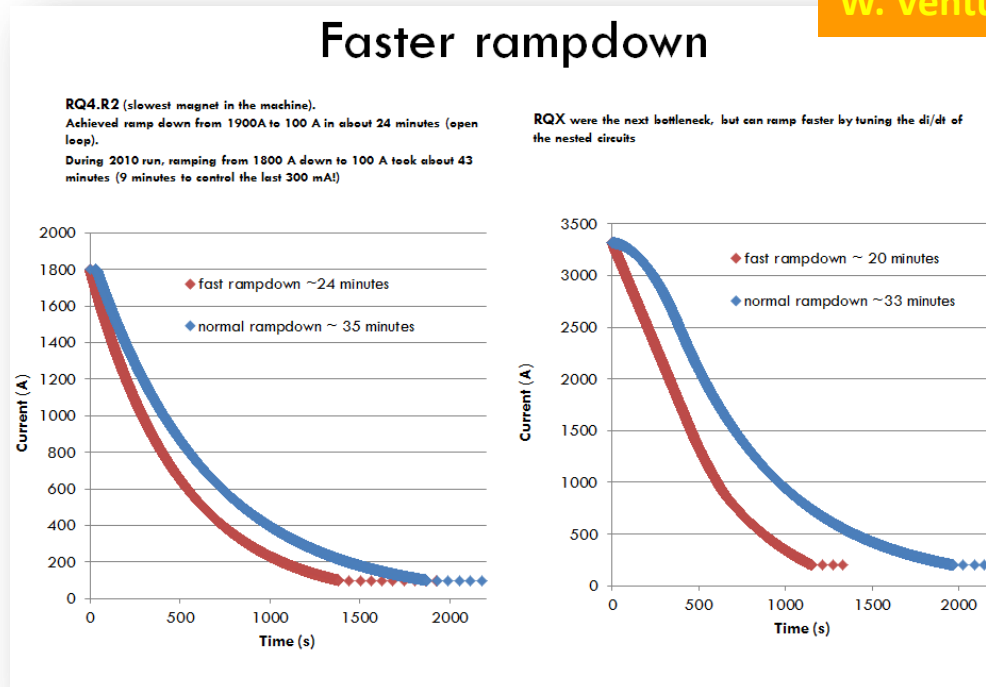


# HOW TO SPEED UP THE NOMINAL CYCLE?



- Once will ramp to 6.5 TeV, Matteo told us that the ramp-down will be far too long. In Evian '11, Walter was suggesting to ramp down faster the IPQs in open-loop mode --> we should commission it!

W. Venturini



- The change of threshold of many circuits (presently under revision, and possibly partially tested in February) could help in speeding-up some operational part (e.g. RCBXs in collision)

- A quick look at the general planning
- Superconducting Circuits Commissioning
  - Thermal amplifier?
  - Powering tests
- System re-commissioning**
- Machine check-out
- Concluding remarks

□ Three main consolidation activities:

1. Consolidation of all HV generators for 7 TeV operation (75%)
2. Installation of missing diluters (2 per side), needed to increase the intensity
3. 12V problem: new synchronization unit from BIC to MKDs

□ In terms of commissioning:

- The generators will not be tested in the lab, will be tested underground; possible **interference with the powering tests** in sector 56 and 67
- **Reliability run** for validation at 7 TeV (in local) – 1<sup>st</sup> semester '14
- **Dry run** (mainly for TSU) – late summer '14
  - Sequencer phase, with arming sequences, ramp and dump
  - Verification of faults and correct functioning
- BIS loop in local for all tests
- **Will need solid software**; no change foreseen on this side, but changes of middleware and FESA classes could be an issue, above all for XPOC (no big changes in philosophy)

**Software well defined (at least environment fixed) since early summer  
Dry runs in 2<sup>nd</sup> semester**

□ **Need time before beam** to test everything correctly





- ❑ A new 3m-long TCDQ will be installed, for which an extensive control validation will be carried out
  - Delivery is foreseen for the end of 1<sup>st</sup> semester '14
- ❑ Concerning the kickers, all magnets will be replaced
  - Long conditioning will be needed
  - No issue for commissioning
  - **Dry run after summer '14**
  - IQC – additional needs and signal input
- ❑ For the MKQA
  - a modification of the internal electrical distribution will be done, which does not affect commissioning
  - A request has been made to change the length and amplitude of the modulation

**Conflict with powering tests and tight timing for qualification**

- The first big intervention will be the modification of klystron cooling (8 klystron over 16 will have to be changed, since 4+4 were changed in the past Christmas breaks)
  - To be re-tested from **end of summer '14**
    - Short-circuit on wave guides to power without closing the area
    - Need of electrical power
    - Need of demineralized water
- The second one is the replacement of one module, containing the sick cavity 3B2
  - A long conditioning will be needed (1.5-2 weeks)
  - **Sector 8 (RF zone) will be closed**  
--> **Interference with the powering tests and other activities** in the area (survey,...)
- Software-wise, the major modification will be the migration to the new versions (e.g., FESA3)
- All RF VMI front-ends will be moved to Linux --> part of the drivers will be re-written
- Fix-displays: idea of having a bunch of fixed-displays is under discussion; data are already available
  - E.g. fast diagnostics on cavity voltage, to give pre-warning and helping in debugging faults

**Conflict with powering tests**  
**No BIS connection till very late**

- ❑ “Complete new damper, built from scratch”

- New cabling
- New front-ends
- Twice number of pick-ups
- New signal processing unit
- New algorithm

End '13

} Mostly '14

- ❑ They cannot, of course, do much without beam

- ❑ Re-commissioning will not take less time than in the past, even if they will have automatic systems to speed up.



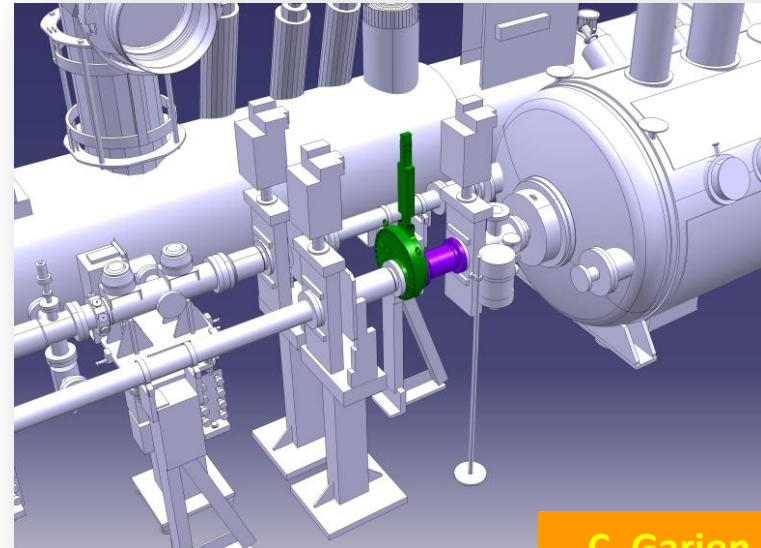
- ❑ Between 22 and 26 new collimators will be installed in LS1:
  - 18 BPM collimators (all IP TCTs + 2 TCS at IP6)
  - 1 or 2 new TCLs per side/beam at IP1 and 5
- ❑ Maintenance plan for the coming 2 years:
  - Move periodically all collimators
  - Avoid damage during LS1 (balisage and protection covers)
- ❑ Software
  - No radical change in the software used for collimator control
  - The new BPM collimators will require a new software, which has been already used in SPS in a prototypal form
  - (For beam re-commissioning, will have to check whether the new BPM collimators can be interlocked – software to be validated)
- ❑ New passive absorbers will be interlocked – temperature sensors to be interlocked
- ❑ No LVDT or step motor systematic replacement
  - No problem of ageing
  - No problem of radiation
  - Acoustic check done and to be re-done

**Calibration for all  
Full MP re-commissioning for all**



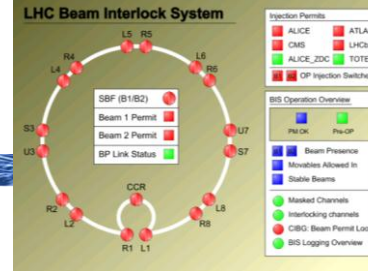
- ❑ Many intervention carried out in LS1
  - BPM and BLM cooling
  - OFB - many modification on HW side
  - Attenuators on the interlock BPMs
  - Additional HW on tune system
  - New optics for light monitors
  - Thinner wires for WS
  
- ❑ Most of them **will only be tested with beam**
  
- ❑ BPM and BLM cooled rack
  - Already in planning
  - Reliability run to be performed well in advance wrt beam
  
- ❑ BLM to be tested with radioactive source
  - Already in planning

- New “transparent” ultra-fast valves to be installed close to the RF cavities to avoid pollution in case of sector34-like event
  - They close in 20 ms vs 1 s of traditional ones
  - Design defined
  - ECR prepared



C. Garion

- They will not be interlocked with the vacuum system, but (most presumably) with some powering signal (PC earth fault detection? QPS?...)
- Software-wise, a new tool should be available to check all interlocks at the beginning of machine check-out



## □ Main issues

- The electronic interface which pilot the CIBUs will be somewhere touched/moved
- The optical fibers are subject to ageing and they are fragile and could be damaged easily + new fibers will be pulled after moving the equipment from UJ56 to USC55
- All BIC processors in the Front-End will be changed due to the change in software and technology no more supported

## □ Ideal re-commissioning of BIS

- Following two years intervention in the tunnel, a conservative approach would consist in re-qualifying all user inputs, which means the CIBUs for all users
- Should be in real conditions, with all users TRUE
- About 250 connections --> 6 months running around the machine, once all interventions are done

**Equipment owners should declare their intervention  
Need time before beam**

## □ More pragmatic solution

- All users moving their electronic interface, will have to declare this intervention (**awareness raising campaign**) --> For these changes, re-commissioning will be done
- **Few (3?) months** before restart, BIS experts will need to enter in test mode on all CIBUs for loop A and B + **1 week** for attenuation measurements (budget is between 3 and 6 dB and the BIS experts will have to pass **after intervention completion**, to clean the connections)



- ❑ The most important changes are those related to R2E, namely
  - The displacement of 9 PIC units, for UJ14/16/56
  - New cables will be pulled and will have to be qualified
  - A **complete re-commissioning** of those systems is needed, which will happen **just before the powering tests**
- ❑ More generally, all units will have to be IS Tested, plus will have to perform PIC1 and PIC2 tests
- ❑ A change will be applied in PVSS for the global protection mechanism (which prevents from powering any circuit in a powering subsector when the big circuits are in fault) – it could be switched ON and OFF, allowing for more flexibility during the powering tests
- ❑ New solution will be deployed for the PIC-LASS interface
  - Now based on software (Laurette's interlock)
  - A new PLC will be connected with the access system
  - A new FESA class will be created in SIS for the access conditions
- ❑ Singularity on the interlock on the temperature of the top part of the current leads
  - Everywhere connected to the PC, it will be connected to the PIC in RR53 (cabling issue)





- Renovation of the control system of the transfer lines
- No change in the LHC
- Re-commissioning of the system in UJ56, following R2E works

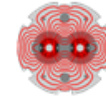


- All machines will be dismantled and remounted, all valves and activators as well
- The software will be re-written
  
- 2 months for re-commissioning of production (no tunnel)
- 4-5 weeks for cool-down
- 1 week of cryo-tuning
  
- Time to tune the systems for frequent ramps**
  
- 1/3 of people left from 2008 commissioning**

**In case of problems (e.g. S/C), huge delay  
Resources issue**



# Smooth versus Radical Changes



- TS: Smooth, localized, backward-compatible upgrades
  - Sector-wide “Smooth upgrades” WG for TS’s in 2012
  - Careful planning and discussion of changes before TS
  - Only backward-compatible changes with possible roll-back
  - Risky/big changes have been deferred to LS1
- During LS1: Radical, global and “big-bang” changes
  - We have to do these changes, to ensure availability and maintainability
  - Changes at all layers (HW, OS, CMW, FESA3, Java, Oracle, ...)
  - CO will thoroughly test in the Controls Testbed
  - Big-bang => Dry runs, lead by OP, are vital for final validation!
  - Tools for supporting smooth upgrades (what has changed, better roll-back)
- Most components will be validated in the Injectors, but OP-organized dry runs remain essential
  - Proposal: 2 months, 2 weeks and 2 days before beam

23

**V. Baggiolini: We have to do these changes, and we will make them work!**



- A quick look at the general planning
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- From Machine Check-out page of 2008:
  - The aims of this checkout are:
    - Drive all relevant systems in a synchronized way through the standard operational sequence
    - Check functionality of the control system from the control room high level applications
    - Check the beam instrumentation acquisition chain
    - Check low synchronization
    - Check all equipment control functionality
    - Check machine protection and interlock systems
  
- What changes from 2008
  - We did it already
  - The infrastructure is already there
  - The software tools are already available and well developed
  
  - Many changes
  - Compressed planning and late delivery of some systems
  - Everybody will be busy till mid '14

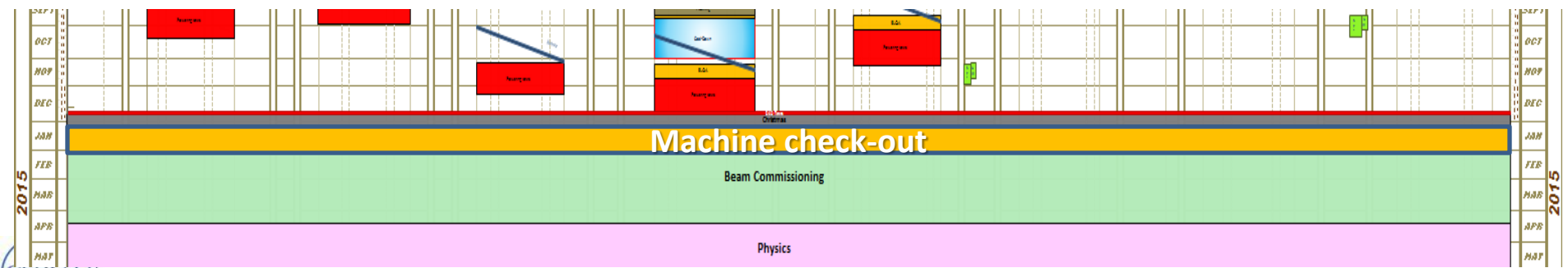


- Preliminary/regular meetings should be organized with equipment owners by the Machine Check-out responsible
  - Starting from Spring '14?
  - Individual system tests (equipment tests toward operational condition) should be performed by the equipment responsible and reported at these meetings
  - On a later phase Functional test will be performed depending on the advancement of the HC
  - Dry runs should be coordinated by OP with the equipment responsible starting from late summer '14
  
- With the actual planning, sector 45 powering tests will give the timing for the final validation
  - Powering tests and machine check-out will cohabit for the last period
  - BIS checks should be done one week before the end of powering tests (see above)
  - The real Machine check out test can only take place at the final phase when the powering tests will be completed and should be 2/3 weeks

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- ❑ It will be a brand new re-commissioning
  - We have a lot of experience, but
  - Two years without running the machine
  - Many changes
  - New people to train
- ❑ Many of us will be busy till August....and later...
- ❑ The software will have to be ready from mid 2014
- ❑ Equipment tests and Dry Runs will be important to revalidate all systems
  - Possible only from end of summer '14
  - They will have to be well coordinated
- ❑ Once the powering tests will be over, we will need at least 3 week of real machine check-out







Thank you  
and  
**MERRY CHRISTMAS**